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Determination of Resistance of Compacted Bituminous Mixture to Moisture-Induced Damage

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Bitumen, Tar and Related Products Sectional Committee, PCD 06

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Bitumen, Tar and Related Products Sectional Committee, had been approved by the Petroleum, Coal and Related Product Division Council.

Indian road transportation infrastructure is rapidly expanding with the ambitious development of road networks under various programs, National Highways Development Programme (NHDP), State Highways Improvement Programmes (SHIPs), Bharat Nirman, Pradhan Mantri Gram Sadak Yojana (PMGSY) etc. The fast growing Indian economy will further demand for road transport network with a high quality pavement structure to cater to very heavy traffic-both in terms of number and axle loading. Currently, majority of the Indian roads are bituminous pavements.

The Committee felt the need to formulate this standard to determine resistance of bituminous mixes to moisture induced damage to evaluate the effects of saturation and accelerated water conditioning of compacted bituminous mixture. The test results may be used to predict long-term stripping susceptibility of bituminous mixtures and to evaluate liquid anti-stripping additives that are added to bitumen or pulverized mineral materials such as hydrated lime, which are added to the mineral aggregate.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DETERMINATION OF RESISTANCE OF COMPACTED BITUMINOUS MIXTURE TO MOISTURE-INDUCED DAMAGE

1 SCOPE

This standard prescribes the method of preparation of compacted bituminous mixtures (specimens) and the measurement of the change of diametric tensile strength resulting from the effects of water saturation and laboratory accelerated stripping phenomenon with one freeze-thaw cycle.

2 REFERENCES

The standards listed below contain provisions which, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

International Standard	*Title*
ASTM D 2041 - 11	Standard test method for theoretical maximum specific gravity and density of bituminous paving mixtures
MS-2 (Published by Asphalt Institute)	Asphalt mix design methods

3 OUTLINE OF THE METHOD

This method includes preparation of compacted bitumen specimens. The mixture is divided into two equal subsets. One subset is tested in dry condition for indirect tensile strength. The other subset is subjected to vacuum saturation and a freeze-thaw cycle (thawing in a hot water bath) before testing for indirect tensile strength. Numerical indices of retained indirect tensile strength properties are calculated from the test data obtained by testing the two subsets: dry and conditioned.

4 APPARATUS

4.1 Vacuum Container — The vacuum container must withstand full vacuum applied, and each must be equipped with the fittings and other accessories required by the test procedure being employed. The vacuum bowl either a metal or plastic bowl with a diameter approximately 180 to 260 mm (7 to 10 in) and a bowl of a minimum height 160 mm (6 in) shall be equipped with a transparent cover fitted with a rubber gasket and a connection for the vacuum line.

4.2 Vacuum Pump — Capable of evacuating air from the vacuum container to a residual pressure of a minimum of 4.0 kPa (30 mm Hg). A suitable trap of one or more filter flasks, or equivalent, shall be installed between the vacuum vessel and vacuum source to reduce the amount of water vapor entering the vacuum pump.

4.3 Balance/Scale — Accurate to 0.1 percent of the test load.

4.4 Water Baths (2 in Numbers) — Capable of maintaining temperatures of 60 ± 1°C and 25 ± 0.5°C.

4.5 Freezer — Maintained at (-18 ± 3)°C temperature.

4.6 Graduate Cylinder — 10 ml.

4.7 Manometer or Vacuum Gage — Suitable for measuring the vacuum being applied at the source of the vacuum. The mercury manometer shall be free of air bubbles to obtain the correct reading.

4.8 Bleeder Valve — Attached to the vacuum train to facilitate adjustment of the vacuum being applied to the vacuum container.

4.9 Loading Jack and Ring Dynamometer — To provide a vertical rate of deformation of 50 mm (2 in) per min and capable of reading the maximum failure load.

NOTE — Marshall Stability testing machine may be used as Loading Jack and Ring Dynamometer.

4.10 Loading Strips — Steel loading strips with a concave surface having a radius equal to the normal radius of the test specimen. The loading strips shall be 12.7 mm (0.5 in) wide for specimens of 100 mm (4 in) diameter. The loading strips for 150 mm (6 in) diameter specimens, shall be 19.05 mm (0.75 in) wide. The length of the loading strips shall exceed the thickness of the specimens. Steel strips are provided at the top and bottom of specimens during indirect tensile testing.

5 PREPARATION OF TEST SPECIMENS

5.1 Specimens approximately, 100 mm (3.937 in) in diameter and approximately, 63.5 mm (2.5 in) thick are normally used.

NOTE — Specimens of other dimensions may be used if the aggregate present is larger than 25.4 mm (1 in) and is not to be scalped out. Specimens of other dimensions may also be used if agreed between buyer and seller.

5.2 At least 6 compacted specimens for each mixture shall be prepared, 3 to be tested dry and 3 to be tested after partial saturation and moisture conditioning with a freeze-thaw cycle. Few extra specimens shall be needed to establish compaction procedures in order to obtain specified air void contents in the test specimens by trial and error.

6 PROCEDURE

6.1 Compact 6 specimens with a Marshall compactor so that the compacted specimens have air voids of 7 ± 0.5 percent. This level of high air voids can be obtained by adjusting the number of Marshall blows applied on each side of the specimen by trial and error (start at about 10 blows as a starting point).

NOTE — Air void content shall be calculated from the bulk specific gravity of the compacted specimen determined by saturated surface dry method as prescribed in MS-2 Asphalt Mix Design Methods and the maximum theoretical specific gravity of the loose bituminous mixture as prescribed in ASTM D 2041.

6.2 Separate 6 specimens into 2 subsets so that the average air voids of the two subsets are approximately equal.

6.3 One set will be tested dry. Keep it at room temperature and then place in a water bath at a temperature of 25 ± 0.5 °C for 2 h prior to the determination of their indirect tensile strength.

6.4 The other subset will be conditioned as follows:

6.4.1 Place and submerge 3 specimens in the vacuum container filled with water at room temperature. Apply a vacuum of 13-67 kPa absolute pressure (10-26 in Hg partial pressure) for 30 min. Remove the vacuum and leave the specimens submerged in water for 5 to 10 min.

NOTE — The water saturation procedure noted above deviates from AASHTO T 283 : 2014 'Standard method of test for resistance of compacted asphalt mixtures to moisture-induced damage', which obtains a specified degree of saturation. The above procedure keeps the time of saturation constant.

6.4.2 Wrap a plastic film around each saturated specimen and place the wrapped specimen in a plastic bag containing 10 ml of water and seal the plastic bag. Place the plastic bag in a freezer at temperature of (-18 ± 3) °C for a minimum of 16 h. Remove the specimens from the freezer.

6.4.3 Place the specimens in a water bath maintained at 60 ± 1°C for 24 h. remove the plastic bag and the plastic film from each specimen after placing the specimens under water.

6.4.4 Remove the specimens from hot water bath and place in a water bath maintained at 25 ± 0.5°C for 2 h.

6.4.5 Remove the conditioned specimens and test for indirect tensile strength.

6.5 Determine the indirect tensile strength of the 3 dry and 3 conditioned specimens at 25 ± 0.5°C after removing from water bath. First, measure their mean thicknesses (*t*). Then, place the two steel loading strips on the bottom and top of the specimens across diameter and place in the Marshall testing machine or a compression-testing machine. Apply load to the specimens diametrically at a vertical rate of 50 mm (2 in) per min.

6.6 Record the maximum compressive strength noted on the testing machine and continue loading until a vertical crack appears in the specimen. Remove the cracked specimen from the machine and visually estimate the approximate degree of moisture damage (extent of stripped or bare aggregate) on the fractured faces of the specimen on a scale of 0 to 5 (5 being the most stripping).

7 CALCULATION

7.1 Calculate the tensile strength of each specimen as follows in S.I. units:

$$S_t = \frac{2\,000P}{\pi t D}$$

Where,

S_t = tensile strength, kPa;

P = maximum loads, N;

t = specimen thickness, mm; and

D = specimen diameter, mm.

7.2 Express the numerical index of resistance of bituminous mixture to the detrimental effects of water as the ratio of the original strength that is retained after accelerated moisture and freeze-thaw conditioning.

7.2.1 Calculate the tensile strength ratio (*TSR*) in percentage as follows:

Tensile strength ratio (*TSR*), percent = (S_2 / S_1) 100

Where,

S_1 = average tensile strength, in kPa, of the dry subset; and

S_2 = average tensile strength, in kPa, of the conditioned subset.

8 REPORT

The mean of the three percentage results shall be reported to the nearest whole number as the "tensile strength ratio (*TSR*)" of the bituminous mixture tested.

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